PLANETARY POLARIZATION NEPHELOMETSER

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We are developing a polarization nephelometer for use on future planetary descent probes. Significantly exceeding the capabilities of previous planetary nephelometers, it will measure both the scattered intensity and polarization phase functions of the aerosols it encounters descending through an atmosphere. These measurements will be taken at two wavelengths separated by about an octave (e.g., 1μm and 500nm). Adding polarization measurements to the intensity phase functions greatly increases our ability to constrain the size distribution, shape and especially the chemical composition of the sampled particles. The NRC Planetary Sciences Decadal Survey has identified probe missions to Venus and Jupiter as a priority. On both of these missions, our proposed instrument would be an excellent candidate for flight. We also expect that future probe missions to Saturn, Uranus, Neptune and Titan would employ our instrument. It could also find use in Earth and Mars *in situ* aerosol studies.

Atmospheric aerosols are key determinants of the global heat balances and atmospheric circulations on all of the above planets. They are as yet still poorly understood. There is a distinct need for polarization nephelometers on descent probes into these planetary atmospheres. For example, for Venus, we have some detailed knowledge of the cloud layers from remote sensing and also from earlier nephelometers placed in Venus' atmosphere on Russian and American probes. But in spite of this detailed knowledge of the clouds on Venus, there are still significant questions that can be answered with a polarization nephelometer at Venus. It would be crucial in fully quantifying the trace gases in Venus' atmosphere. If a probe only measured the gas phase abundances of sulfur bearing molecules it would exclude roughly 1/3 of the sulfur, which may be in aerosols. Current greenhouse models still leave open debates about the relative importance of various contributors to the observed temperature on Venus. The clouds represent a substantial absorber of solar and thermal energy on Venus, and defining their microphysical properties and vertical structure is critical in fully understanding the mechanisms that control the greenhouse. A prime example is that the upper cloud has a still unknown blue absorber, responsible for about 1/4 of all solar energy absorbed by Venus. Identifying this absorber is a task that our proposed polarizing nephelometer would be ideally suited to. For Jupiter, we know even less about the clouds than for Venus. Remote sensing has revealed significant facts about Jupiter's clouds, but important ambiguities still remain (e.g., West *et al*., 1986). An example of this is that we do not know the vertical structure of the clouds on Jupiter. For instance, the contrast-bearing cloud deck may be composed of either ammonia or ammonium hydrosulfide aerosols. Remote sensing studies have been unable to agree on this point, with visible wavelengths tending to support ammonia clouds bearing the contrast (e.g., Banfield *et al.*, 1998), and near-infrared wavelengths indicating ammonium hydrosulfide (e.g., Irwin *et al.*, 2001). A nephelometer on a Jupiter descent probe, entering a representative region of the planet would easily clarify the vertical structure and specific constituency of Jupiter's clouds.

We are using a technique to simultaneously measure intensity and polarization phase functions via polarization modulation of a light source. A similar technique has been implemented in laboratory settings, but not with considerations to the environment on a planetary descent probe. Using recently awarded NASA PIDDP funding, we are developing and building a flexible breadboard nephelometer to verify our approach and candidate components. This will be tested against well defined aerosols and other simple scatterers ensuring that it accurately measures their expected intensity and polarization phase functions. With the knowledge gained in this flexible design, we will design and build the breadboard polarization nephelometer more suited to integration on a planetary descent probe. All of these investigations are being carried out to enhance the likelihood of success and useful data return of our proposed instrument in its descent through a planetary atmosphere. Considerations are also being given to mass, volume, power and cost.